

Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

Guidelines for Producing Hardwood Structural Lumber for Glulam Production

Overview

The Pennsylvania Department of Transportation (PennDOT) and the Pennsylvania Department of Conservation and Natural Resources (DCNR) are building hardwood glued-laminated (glulam) timber bridges. Much of this activity is a result of recent innovations that allow less restrictive quality characteristics of lumber used for hardwood glulam timber manufacture. Glulam timber bridges provide a unique new market for the hardwood industry. Besides highway-rated and light vehicular or pedestrian timber bridges, the glulam technology innovation offers to expand hardwood use for building material into other applications, such as timber frame homes and post-frame construction of agricultural or industrial structures. The Pennsylvania DCNR has established a long-term construction program with over 150 priority structures that need to be improved in order to maintain state forest and state park access. In addition, PennDOT has established a program to document the cost efficiency in the installation of glulam timber decks that will replace existing deteriorating bridge decks currently supported by steel beams. This program will include one glulam timber replacement deck project in ten of its eleven districts. Many of these structures and other short span municipal projects can be fully satisfied with hardwood glulam timber bridges. These current activities are being facilitated by the Pennsylvania Rural Development Council's Timber Bridge Working Group.

During construction year 1997, eleven glulam bridges were designed. Seven of these projects were constructed for Pennsylvania DCNR. During construction year 1998, PennDOT completed the rehabilitation of a weight-restricted bridge by replacing the existing deck with a glulam timber deck. Other hardwood-based bridges are scheduled for construction. The hardwood of choice has been red maple because of lower demand for appearance applications and because of its strength and ease of preservative treatment. To date, a limited number of hardwood producers serve the role of supplying hardwood material for use in glulam production. With the increased number of bridge projects, additional suppliers are essential to meet the demands for lumber. Projects require that between 500 and 1,000 board feet (BF) of lumber per lineal foot of bridge superstructure be provided to the glulam fabricator. Lumber volume ranges between 25 MBF and 50 MBF for typical bridge projects. Projects where steel I-beams in conjunction with a timber deck are used to minimize superstructure depth require less lumber.

Bridge designs developed for applying glulam technology exclude the need for wide dimension hardwood lumber. Glued-laminated bridge decks and girders are adapted to use nominal 6-inch or narrower 4-inch width lumber. With recent changes to the hardwood glulam manufacturing standard, glulam timber production does not require top quality material, such as outer log portions that are better utilized when sawn to yield the higher grade of appearance lumber. Sawmills can practice hardwood grade recovery from the quality log portion followed by cant sawing to yield dimension lumber. Mineral streaks and heart discoloration reduce the acceptability of lumber used for appearance applications, but are admissible in dimension lumber. Sawmill operations can maintain production sales of appearance lumber and supply red maple lumber for glulam production.

U.S.D.A., NAL

June 1999



USDA
Forest Service

Pennsylvania Rural
Development Council



DEC 22 2002
Cataloging Prep



Description of Fact Sheets

Three fact sheets have been prepared to familiarize potential hardwood suppliers with essential requirements to process lumber suitable for structural glulam manufacture. Fact Sheet 1 describes the Dimension Requirements, Fact Sheet 2 provides information about the structural grades and special grading requirements, and Fact Sheet 3 lists key points for producing hardwood structural lumber for glulam products. Structural glulam refers to an engineered, stress-rated product comprising assemblies of suitable selected and prepared wood laminations bonded together with durable adhesive. Hardwood suppliers do not need to visual stress rate (VSR) their dimension lumber to establish structural grade. VSR determinations can be made at a glulam facility while sorting lumber to meet other more specific lamination grade criteria. Glulam manufacture includes extensive amounts of VSR No. 2 structural lumber for bridge deck and girder fabrication. The fact sheets summarize important information to be used as a general guideline to process hardwood that meets minimum VSR No. 2 characteristics acceptable for glulam timber manufacture.

A major difference between hardwood used for appearance applications and hardwood used for structural application is kiln drying to only 15 percent moisture content (MC). Following moisture reduction, further processing includes surfacing four sides (S4S) to a minimum dry dimension. Questions often arise over acceptable length; longer lumber is not a prerequisite. To minimize lumber distortion, it is advantageous to the sawmill to avoid lengthy hardwood logs, especially when applying the cant sawing strategy, and to maintain lumber at an 8-foot or 10-foot length with adequate trim to allow squaring and removing end splits. Hardwood producers should discuss the acceptance of shorter length lumber directly with glulam fabricators that purchase structural lumber products.

John Janowiak
Associate Professor — Wood Science
The Pennsylvania State University
School of Forest Resources — Wood Products
307 Forest Resources Laboratory
University Park, PA 16801
Phone: 814-865-5722
Fax: 814-863-7193

Jeff Kimmel
Research Support Technician II — Wood Products
The Pennsylvania State University
School of Forest Resources — Wood Products
307 Forest Resources Laboratory
University Park, PA 16801
Phone: 814-863-3228
Fax: 814-863-7193

Products, designs, and treatments mentioned by contributors from outside the USDA are not necessarily endorsed by the USDA, nor do statements made herein reflect the policy of the USDA. In all cases, consult with appropriate professional and state or local regulatory agencies for conformance to applicable laws and regulations.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or familial status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotope, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 14th and Independence Avenue, SW, Washington, DC 20250-9410 or call (202) 720-5964 (voice or TDD). USDA is an equal opportunity provider and employer.

Producing Hardwood Structural Lumber for Glulam Production

Fact Sheet 1 -- Dimension Requirements

- Laminating stock lumber needs to be *6 feet* or longer and *double end trimmed* reasonably square within 1/8-inch, preferably not over 3 inches in excess of multiples of 1 foot.
- Uniform and consistent* surfaced (S4S) dimensions *are essential* for laminating stock. Lumber surfaced to a *width less than the minimum* (dry) specified dimension *will not* be usable for the intended purpose.
- Standard nominal structural dimension lumber sizes listed in the table are the preferred standard thickness and widths for glulam manufacture, but other sizes may be optional per request from the glulam timber fabricator.

Table -- Lumber sizes. Nominal and *minimum-dressed* sizes of some dimension lumber used as glulam laminating stock.

Thickness			Face width		
Nominal	Minimum dressed		Nominal	Minimum dressed	
	Dry	Green		Dry ⁽¹⁾	Green ⁽²⁾
2	(in.) 1-1/2	(in.) 1- 9/16	4	(in.) 3-1/2	(in.) 3-9/16
			6	5-1/2	5-5/8
			8	7-1/4	7-1/2

⁽¹⁾ Nominal size of laminating stock most frequently required for glulam timber bridges is hardwood sawn 2x6 (1-1/2-inch by 5-1/2-inch S4S finished dressed dimension) or 2x4 (1-1/2-inch by 3-1/2-inch S4S finished dressed dimension).

⁽²⁾ Green refers to semi-dried lumber above 19 percent MC and is not used for lamination stock within glulam manufacture.

- Surfacing quality* allowance for No. 2 grade visual stress rated (VSR) structural dimension permits *hit and miss skips* not over 1/16" deep with surfaced areas between, and up to 5 percent of the pieces with miss up to 1/8" deep not longer than 2 feet.
- Dry or kiln dried laminating stock must be of a *uniform* and *consistent* moisture content equalized to *12 percent* (15 percent maximum) for proper development of adhesive bond quality.
- Cant sawn lumber is acceptable* for laminating stock *but* will usually have higher shrinkage and more extreme warpage (bow, crook, cup, and twist). Heavier cutting is recommended for cants and smaller diameter logs, especially in width.

Producing Hardwood Structural Lumber for Glulam Production

Fact Sheet 2 -- Structural Grades and Special Grading Requirements

- VSR lumber is graded on *all 4 faces*, and grades are limited by strength and stiffness reducing defects (e.g., knots according to size and location, slope of grain, splits, unsound wood, wane, and warp). Permissible edge and centerline knots have been summarized for reference in the table.

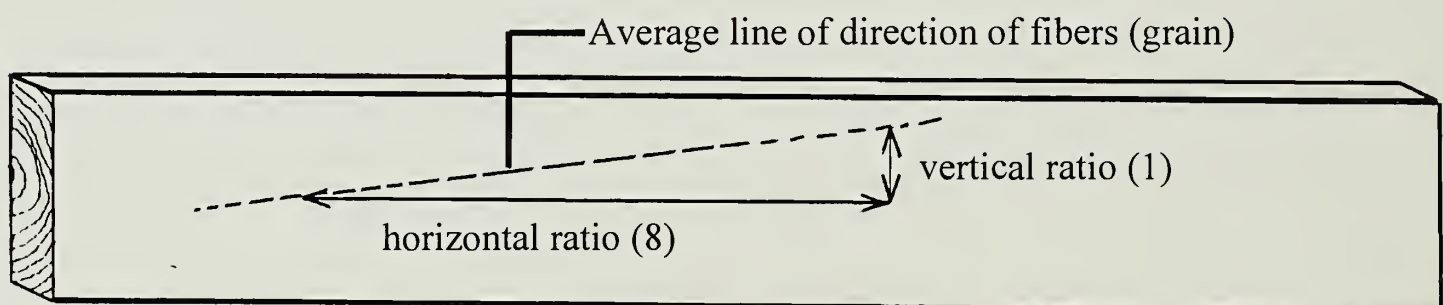
Table -- Knot limitations. Knot size limitation requirements for No. 2 VSR (Well spaced knots of any quality are permitted in sizes not to exceed the following or equivalent displacement).

Nominal width	At edge wide face	Centerline wide face	Holes (any cause)
	(inches)	(inches)	(inches)
4	1-1/4	2	1-1/4
6	1-7/8	2-7/8	1-1/2
8	2-1/2	3-1/2	2

one hole or equivalent smaller holes per 2 lineal feet

- After allowable knot size, structural lumber grade is often controlled by *slope of grain* (deviation of wood fiber from a line parallel to the edges of the piece). No. 2 VSR lumber is limited to a slope of grain of 1-in-8 as illustrated in the Figure.

Figure. Illustration of slope of grain of 1-in-8 permitted for No. 2 structural grade dimension lumber.



- Although VSR and machine stress-rated (MSR) lumber grades have allowances for *end splits* (including through checks and shake) and *end knots* (knots at a distance < 2 knot diameters from ends), these defects *should be trimmed where possible* (preferably after drying) for lumber to be effectively used as lamination stock which will be end-jointed as part of the laminating process.
- Surface quality* for No. 2 VSR (see the fourth bullet on Fact Sheet 1) will be acceptable for most lumber purchased for glulam fabrication.
- Wane* is permitted for many structural grades and acceptable for some laminating stock; however, lumber must be of full cross section (i.e., no significant wane) for it to be E-rated by the manufacturer.
- Decay* is acceptable but limited to heart center streaks or light pockets < 1/3 the width or thickness.

Producing Hardwood Structural Lumber for Glulam Production

- *Warp* allowance for No. 2 VSR is light and specified according to the nominal face width dimension and/or length measured after surfacing. (See the following tables for each type of warp: cup, crook, and twist.) Maximum light *bow* permitted is three times as much as crook permitted for 2-inch faces.

Table -- Cup allowance. Maximum light *cup* permitted for hardwood to meet No. 2 VSR lumber grade.

Nominal Face Width and Cup (inches)		
4	6	8
1/32	1/16	1/8

Table -- Crook allowance. Maximum light *crook* permitted for hardwood to meet a No. 2 VSR lumber grade.

Length (feet)	Nominal Face Width and Permitted Crook (inches)		
	4	6	8
6	1/4	3/16	1/8
8	3/8	5/16	1/4
10	1/2	7/16	3/8
12	11/16	5/8	1/2
14	7/8	3/4	5/8
16	1	7/8	3/4

Table -- Twist allowance. Maximum light *twist* permitted for hardwood to meet a No. 2 VSR lumber grade.

Length (feet)	Nominal Face Width and Twist (inches)		
	4	6	8
6	3/8	1/2	3/4
8	1/2	3/4	1
10	5/8	7/8	1-1/4
12	3/4	1-1/8	1-1/2
14	7/8	1-1/4	1-3/4
16	1	1-1/2	2



Producing Hardwood Structural Lumber for Glulam Production

Fact Sheet 3 -- Key Points

1. Mills will benefit if sawers, trim saw operators, and graders become familiar with No. 2 VSR grade restrictionsⁱ on allowable strength-reducing defects and lamination stockⁱⁱ processing requirements.
2. Saw heavy, especially in width, from cants or smaller diameter logs to compensate for extreme shrinkage and to assure minimum dressed dry dimensions are attained. Uniform and consistent final dimensions are essential for laminating stock, while minimum dressed dry lumber thickness is less critical than minimum width and surface quality requirements.
3. Kiln drying should be performed utilizing end-grain coating to avoid end-splits, and use of proper stickering procedures to control warp and bow; equalize lumber to 12 percent MC, 15 percent maximum.
4. Double end trim to a minimum of 6 feet to remove as many end splits and end knots as possible. Even-length lumber is preferable over odd lengths. Avoid hardwood logs longer than 10 feet to minimize lumber distortion.
5. Sawing dimension lumber from smaller diameter logs or residual cant processing might prove more profitable than pallet cant or rail tie production. Yields of over 80 percent VSR No. 2 and Btr dimension lumber are possible from resawn red maple cants.
6. Avoid processing cants where heavy taper logs have been sawn parallel to bark; processed lumber will tend to have high slope of grain characteristics with increased amount of lumber warpage.
7. Packs for transport should be of same size lumber (width and length) with wrap protection to avoid rewetting. It is advisable to clearly label pack units with lineal footage and piece count of nominal size lumber.

ⁱThe American Softwood Lumber Standard PS 20-93 established the National Grading Rule for Softwood Dimension Lumber which has been adopted to include hardwood dimension lumber; *Standard Grading Rules for Northeastern Lumber* - 1991, Northeastern Lumber Manufacturers Association (NELMA), 272 Tuttle Road, P.O. Box 87A, Cumberland Center, ME 04021. Structural light framing and structural joist and plank sections for 2" nominal thickness dimension No. 2 grade of the National Rule have been outlined in these *Fact Sheets*.

ⁱⁱLaminating stock restrictions are in accordance with American National Standard ANSI/AITC A190.1 - 1992, *Structural Glued Laminated Timber*, American Institute of Timber Construction (AITC), 7012 South Revere Parkway, Suite 140, Englewood, CO 80112.

